JOURNAL OF TECHNICAL EDUCATION AND TRAINING VOL. 12 NO. 1 (2020) 197–203

JTET

http://penerbit.uthm.edu.my/ojs/index.php/jtet
ISSN 2229-8932 e-ISSN 2600-7932

Journal of Technical Education and Training

Design and Technology Teacher in TVET: A View on Thinking Style and Inventive Problem-Solving Skill

Tze Kiong Tee[1*], Shanty Saien[2], Fahmi Rizal[3], Sukardi[4], Risfendra[5], Mei Heong Yee[6], Mimi Mohaffyza Mohamad[7], Widad Othman[8], Mohamed Nor Azhari Azman[9], Nurulwahida Azid[10]

[1,2,6,7]Faculty of Technical and Vocational Education,
Universiti Tun Hussein Onn Malaysia, Parit Raja, 86400, Johor, MALAYSIA

[3,4,5]Faculty of Engineering, Padang State University, Sumatera Barat, INDONESIA

[8]Faculty of Education and Linguistic, Open University Malaysia, Kuala Lumpur, 50480, MALAYSIA

[9]Faculty of Technical and Vocational, Universiti Pendidikan Sultan Idris, Perak, 35900, MALAYSIA

[10]School of Education and Modern Languages, Universiti Utara Malaysia, Kedah, 06010 MALAYSIA

*Corresponding Author

DOI: https://doi.org/10.30880/jtet.2020.12.01.021
Received 11th December 2018; Accepted 30th May 2019; Available online 31st March 2020

Abstract: Teachers play an important role to help student in solving problem in school and consequently preparing for their future career. Teachers can be the most important feature to expose thinking style in class. This is the implication of Technical and Vocational Education and Training programme which requires the students to be able to think creatively and critically in problem-solving. As inventive problem solving is known to be creative assessment methods for innovation, it is needed to guide Design and Technology teachers to expose the student new technique of solving a problem. This study attempts to investigate teachers' perception of their thinking style and inventive problem-solving skill. The importance of thinking styles in inventive problem-solving skill and the factors contributing to the achievement to inventive problem solving are also discussed. Data were collected from 367 Design and Technology teachers across Malaysia. Data obtained were analyzed descriptively. This study confirmed that teachers know the role of thinking style in solving a problem. They also admit that inventive problem-solving skill is important but half of them still having problem to master the skills. Problem identification is claimed to be a vital process in solving a problem but yet, majority of them still facing problem in finding the root cause. As a counter-measures on this miss-alignment, modules are needed by teachers to help them integrating their thinking styles into teaching and learning in class. Module also acts as teaching aids for teachers in guiding them solving inventive problems.

Keywords: Thinking style, problem-solving, inventive problem-solving, problem identification, module

1. Introduction

The present generation and technology explosion shows the beginning of the globalization era in which the nations of the world are working to advance their respective countries to form a solid-state. Malaysia has also endured many changes in line with time. Thus, the development of the country based on its mould should be implemented through various channels. One of the Six Strategic Trusts in the Eleventh Malaysia Plan, 2016-2020 is shifting towards

*Corresponding author: tktee@uthm.edu.my

industry-led programmes to produce a skilled workforce to meet the changes by employing Technical and Vocational Education and Training (TVET) programme. This plan shows how important the education channel is. It pursues the economic, political, social development and technological forces.

As Vision 2020 is the framework for becoming a developed nation, education is hope to be able to serve the main agenda to form a community that shapes the formation of the nation. This has been appropriately stated by Rasul et al. (2015) that a quality and skilled workforce is very crucial as the ingredients in Vision 2020. Ismail & Abiddin (2014) added that to support and shapes the nation, Malaysia will need an educated and quality skilled workforce. Education plays an important role in preparing a good quality skilled workforce. Thinking skills are very important to the workforce as it helps to think holistically and synthesize information, to integrate environmental and societal values and ethics into work and solve the problem in creative ways (Boer, 2014). Thus, one of the important goals in education is improving thinking ability, and schools are considered places where thinking skills can be enhanced. The thinking ability or thinking skills can be interpreted as an intellectual process involving the conceptualizing, application, analysis, syntax, or assessment of collected or generated information through observation, experience, reflection, propensity, or communication (Idris, Ariffin, & Ishak, 2009). Since, it has been known to be the cornerstone of creating a creative educational development among students (Chew & Nadaraja, 2014). Thinking Skills Model is introduced by the Ministry of Education Malaysia. This thinking model has been used since 1994 which emphasize critical and creative thinking and problem-solving to prepare the student for future demand, especially in employability skills. This is in line with Roy (2012) that thinking skill is very important that it shouldn't be lost in the curriculum.

The thinking model which better known as KBKK (Critical and Creative Thinking Skills) is adapted in all subjects in school. One of them is Design and Technology (DT) subject which aims to formulate and develop capabilities in design and technology as well as business and entrepreneurship. These basic skills enable students to be independent and productive in life. This will bring a change to students in line with the government's goal of generating first-class human capital in the 21st century (Ismail, 2012). Nevertheless, Malaysia Higher Education Blueprint also stated that one of the 5 major shifts to address future outlook is to have a high quality of Technical and Vocational Education and Training (TVET) graduates. Undeniably, the preparation and exposing these students to the TVET career path in the early stage seems to be vibrant. The commitment of DT teachers in preparing the students physically, emotionally, spiritually and intellectually is required to meet this desired outcome.

2. Problem Background

The needs in the 21st century have to be specified, as education has come under criticism from many sectors (Foshay & Kirkley, 2003). For example, in industrial sectors, problem-solving skill is the basic skills required by the employee (Wan Mohamed & Omar, 2010). Thus, to teach and develop this skill at the very beginning, teachers have looked for ways to reform teaching, learning, and the curriculum especially in uplifting this utmost skill. As inventive problem solving is known as the utmost skill needs in today's world (Omar, 2015) which has also been admitted by Abdul Latif (2014), it is undeniable needs for teachers to be a good problem solver. Inventive problem solving also known to be creative assessment methods for innovation (Buzuku & Shnai, 2018).

Unquestionably, innovation and product design come from one component, hence Inventive problem solving is very important in DT subject to boost up students' creativity to design innovative products (Wang & Zhang, 2017). Meanwhile, as Malaysia Education Blueprint 2013 – 2025 states that teacher quality is the most significant factor in determining student outcomes, Doménech-betoret & Gómez-artiga (2014) also stressed that students also perceived that teacher has a good thinking style which will carry a high quality of learning session. Thus, teachers need to have sufficient knowledge and skills of inventive problem solving for them to deliver good teaching.

Tee, Saien, Yee and Mohamad (2017) stated teacher is the person who is responsible to expose problem-solving to generate ideas to develop solutions that are more effective and practical. Ismail (2012), in his study, has the same question as a researcher, do the teacher prepared to teach this skill? And this question leads to the teachers' perception of their skills. Hence this paper will discuss teachers' perception of their thinking style, inventive problem-solving skills, and problem identification. The importance of thinking style in Inventive problem-solving and factors contributing to the achievement of inventive problem-solving skills will also be elaborated. This will conclude how does the teacher's perception is important to determine the success of their student in designing creative and innovative products to cater to current technology needs.

3. Methodology

This research used the quantitative approach with survey design. The surveys in this study were managed through Google Docs. Google provides a service that allows creating forms and documents online. It then can be shared with anyone who has access to the Internet. The survey form was sent out through email, Facebook, WhatsApp, Instagram and Telegram for the respondents to complete one time. The respondents will not be able to see one another's responses (Nulty, 2008) because the program automatically puts the results into a spreadsheet for further data analysis.

3.1 Population and Sample

The population for this study is identified appropriately. The target population was primary school Design and Technology teachers who had experience teaching Design and Technology and teachers who are teaching Design and Technology in this current year. The target was the Design and Technology teacher across Malaysia. A volunteer sampling technique was applied in this research. There are 7772 primary schools in Malaysia. According to Krejcie & Morgan (1970), the minimum number of samples is 367 respondents. Table 1 segregates the number of population and samples in every state in Malaysia.

Table 1 – The Population and Sample of DT Teachers in Malaysia

Zone	State	Population	Sample
Zone 1	Sabah	1072	51
	Sarawak	1264	60
	Labuan FT	17	1
Zone 2	Johor	905	43
	Melaka	237	11
	Negeri Sembilan	349	16
Zone 3	Perak	852	40
	Selangor	659	31
	Kuala Lumpur FT	202	9
	Putrajaya FT	14	1
Zone 4	Kelantan	418	20
	Pahang	539	25
	Terengganu	352	17
Zone 5	Kedah	547	26
	Pulau Pinang	271	13
	Perlis	74	3
		7772	**367**

3.2 Research Instrument

A set of questionnaires that consist of 20 items was used as a research instrument. The questionnaire is divided into two parts. Part A comprises three items related to demographic factors including gender, education level and years of teaching. While Part B consists of 20 items of two choice answer, 'Yes' and 'No'. However, a link is also given to teachers who wish to identify their thinking style. This link, which accessing the thinking style test, will be appeared after teachers completed the 20 items. Prior to the actual research, a pilot test was conducted to determine the reliability of the instrument and to achieved the desired objective of this study. The reliability of this set of instruments is α = .872. The survey instrument used to measure teachers' perception is sought to find out as in Table 2.

Table 2 – Themes From The Questionnaire per Item

	Theme	Abbr.	Total Item	Question No.
1	Thinking Style	TS	5	1,2,3,5,7
2	Inventive Problem-Solving Skills	IPS	7	4,6,8,9,11,12,13
3	Problem Identification	PI	6	14,15,16,17,19,20
4	Module	M	2	10,18

3.3 Data Analysis

Overall, 367 data managed to be collected. It is then analyzed according to the theme as illustrated in Table 3. Frequencies and percentages were employed for every theme in Table 2 on teachers' perception of their thinking style and inventive problem-solving skills, problem identification and module. The percentage resembles the 'Yes' answer from the respondents.

Table 3 – The Coding For Each Item in The Questionnaire

Item	Abbr.
I know my thinking style	TS1
I know thinking style is important to solve inventive problem	TS2
I need to know my thinking style	TS3
I need to master inventive problem solving	**IPS1**
I believe my thinking style can help me in solving inventive problem in DT	TS4
I believe my problem-solving skills can help me to solve inventive problem in DT	**IPS2**
I believe thinking skills has a close relation to inventive problem solving	TS5
I know problem-solving skills model/s	**IPS3**
I know inventive problem-solving skills is important in solving problem in DT	**IPS4**
I believe Thinking Style Modul and Inventive Problem Solving can help me in solving problem in DT	M1
I mastered Inventive Problem-solving skills in DT	**IPS5**
I have problem in solving inventive problem in DT	**IPS6**
I totally depend to textbook and DSKP (Curriculum Standard Document) in problem-solving in DT	**IPS7**
I know problem identification is one of the phase in solving problem	*PI1*
I know problem identification is important phase in problem-solving	*PI2*
I need to master problem identification.	*PI3*
I believe by doing problem identification or to state problem can help me to solve problem	*PI4*
I believe Modul of problem identification can help in solving problem in DT effectively	M2
I mastered problem identification skills in design process	*PI5*
I have problem in identifying problem in DT	*PI6*

4. Result

The result will be discussed in terms of teachers' thinking style, their perception of inventive problem solving, how they justify problem identification and the countermeasure of having module as a teaching aid.

4.1 Teachers' Thinking Style (TS)

99.2% of teachers agreed that thinking style does have a close relation to inventive problem-solving. How close the relation is, has been discussed by Toivonen (2015); Hsiang-tang & Jahau (2003); Berdonosov (2015) which agreed that thinking style does take part in how the problem will be solved. Hence, a certain type of thinking style will lead to a different way of solving a problem. Most teachers perceive that they know their thinking style and understand the importance of thinking style. They can relate that by having the right thinking style, it will help them to solve the problem they face. Temel (2014) agreed that on the contrary, the teacher tends to ignore the problem they face if they lack thinking skills.

Based on this study the perception of most teachers in Malaysia in knowing their thinking style is undeniably needed, however; their action does not always align. 96.4% of teachers agreed that they need to know their thinking style but only 72% showed up to access the thinking style test. This might because they know their thinking style and do not need further confirmation or they do not need to know their thinking style even though they answered 'Yes' in item TS3 as in Table 4. Another factor is might be due to the medium that the researcher used. It was online and one should complete the test at once. The teacher perhaps having difficulty in the process of answering the question and couldn't proceed to complete it.

On the other side, even though 97.3% said they know their thinking style but 72% of them showed up to answer the thinking style test. Again, it is not aligned. The only factor is that teachers are not sure of what type of thinking style they have. Thus, they need to have certainty of their thinking style.

Table 4 – The Percentage of Thinking Style per Item

Code	TS1	TS2	TS3	TS4	TS5
	I know my TS	I know the important of TS	I need to know my TS	I believe it will help me to solve problem	It has close relation to IPS
Thinking Style (TS)	97.3	99.2	96.4	96.4	99.2

4.2 Teachers' Perception of Inventive Problem Solving (IPS)

Based on the study, most teachers agreed that problem-solving skills are very important that they need to master it. It helps them to solve the inventive problem. Despite knowing the importance of it, only 65.2% of them know the problem-solving models as in Table 5.

In the context of Design and Technology, 93.7% of teachers know the importance of inventive problem-solving skills but only 67% of them perceive master in it. 93.7% resembles most of the Design and Technology teachers in Malaysia who do know inventive problem-solving. They may have the fact that the inventive problem solving is the most comprehensive, systematically organized invention knowledge and creative thinking methodologies (Cavallucci et al., 2015) that drives them to answer 'Yes' in IPS1.

53.3% of teachers claimed they do have difficulties in teaching inventive problem solving to their student and about half of the respondents are using a textbook or standard curricular documents to expose problem-solving skills in their class. The use of these teaching aids can be seen as an alternative way to assist them in their classes.

Table 5 – The Percentage of Problem-Solving Skills per Item

Code	IPS1	IPS2	IPS3	IPS4	IPS5	IPS6	IPS7
	I need to master IPS	I believe it helps	I know the model/s	I know IPS important in DT	I mastered IPS in DT	I have a problem	I totally depend on
Problem-Solving Skills	99.2	99.2	65.2	93.7	67.0	53.3	47.4

4.3 Teachers' Perception in Problem Identification (PI)

An inventive problem is a problem that has negative side effects after the solution is achieved. According to Genrich Altshuller, a patent examiner for the Russian Navy, Inventive Problem Solving has systematic methods and tools for analysis which will support the decision-making process (Labuda, 2015). It consists of problem identification as its first step.

Thus, for this study, as for problem identification, almost all teachers admit that the importance of this first step in the problem-solving phase; to state a problem. They claimed that they need to master problem identification for them to solve the problem. By doing the problem identification process, it helps the teachers to define what is the root cause of a problem. 65.2% of teachers perceived that they mastered the problem identification but yet lose confidence whether their judgment is right (59.7%) as in Table 6.

Table 6 – The Percentage of Problem Identification per Item

Code	PI1	PI2	PI3	PI4	PI5	PI6
	I admit PI is one of the problem-solving phase	I know PI is important phase	I need to master PI	I believe IP can help	I mastered	I have problem PI
Problem identification	88.2	93.7	98.3	98.3	65.2	59.7

4.4 Module

As the miss-alignment happen between IPS5 and IPS6 (Table 5) which shows, teacher perceived that they have master the Inventive Problem Solving but yet they claimed they still have problem in the DT subject, it was good to have 88% of teachers perceive that Thinking Module is needed (Table 7). This module will help the teacher in their DT class. Most of the teacher admits the close relation of thinking style and inventive problem-solving.

Table 7 – The Percentage of Thinking Style per Item

Code	M1	M2
	The needs of Thinking Module	The needs of PI Modul
Module	88.0	93.7

On the other hand, as in Table 6, teachers perceived that they mastered the problem identification but yet lose confidence whether their judgment is right. As a countermeasure, the majority of teachers agreed on the needs of a reference that can guide them on how to identify the problem. Hence, the only factor of how teachers can successfully solve inventive problem solving is having the module as a teaching aid.

5. Conclusion

Thinking style can help the workforce to think holistically and solve the problem in a creative way (Osterman, 2015). The unawareness of oneself thinking style will lead them to be ignorant to solve the problem (Temel, 2014). Thus, it is the teachers' role to encourage awareness of thinking style and to foster inventive problem-solving skills in their students at an early age. Despite the fact that teachers perceived that they know their thinking style but they still need teaching aids to help them in class. They agreed on using the module as their teaching aids to expose students to inventive problem-solving skills. This effort will therefore benefit the student as they are the future workers of tomorrow. The limitation of this paper is that it only provides the teacher's perception of their thinking style but what type of thinking style they have was not stated. Future research can be focused on the type of teacher thinking style and what thinking style is considered best to lead to the achievement of solving a problem. Despite this limitation, the discussion in this paper can assist in better development of teaching aids that will boost teacher to prepare the student for 21st Century demand, especially in technical employability skills.

Acknowledgement

This project was financially supported by the Malaysia Ministry of Education under Geran Pensiswazahan Guru (PPG) Vot V010, Universiti Tun Hussein Onn Malaysia.

References

Abdul Latif, A. M. (2014). *Pembangunan Kemahiran Penyelesaian Masalah Berlandaskan Projek Origami*. *Tesis PhD*. UTHM.

Berdonosov, V. (2015). Concept of The TRIZ Evolutionary Approach in Education. *Procedia Engineering*, *131*, 721–730. https://doi.org/10.1016/j.proeng.2015.12.362

Boer, A.-L. de. (2014). Thinking Styles and Their role in Teaching and Learning. Retrieved from https://www.researchgate.net/publication/252400208%0AThinking

Buzuku, S., & Shnai, I. (2018). A systematic literature review of TRIZ used in Eco-Design A systematic literature review of TRIZ used in Eco-Design. *Journal of the European TRIZ Association 02-2017 (04) 1*, *04*(January).

Cavallucci, D., Cascini, G., Duflou, J., Livotov, P., & Vaneker, T. (2015). TRIZ and knowledge-based innovation in science and industry. *Procedia Engineering*, *131*, 1–2. https://doi.org/10.1016/j.proeng.2015.12.341

Chew, F. P., & Nadaraja, S. (2014). Pelaksanaan Kemahiran Berfikir Kreatif Dan Kritis Dalam Pengajaran Dan Pembelajaran Komsas Di Sekolah Menengah. *Jurnal Pendidikan Bahasa Melayu-JPBM (Malay Language Education Journal – MyLEJ)*, *4*(2), 10–24. https://doi.org/10.1145/1306813.1306843

Doménech-betoret, F., & Gómez-artiga, A. (2014). The Relationship Among Students ' and Teachers ' Thinking Styles , Psychological Needs and Motivation. *Learning and Individual Differences*, *29*, 89–97. https://doi.org/10.1016/j.lindif.2013.10.002

Foshay, R., & Kirkley, J. (2003). *Principles for Teaching Problem Solving*. PLATO Learning, Inc., 2003.

Hsiang-tang, C., & Jahau, C. L. (2003). Eco-Innovative Examples for 40 TRIZ Inventive Principles. *Triz-Journal*, 1–16. Retrieved from http://www.triz-journal.com/archives/2003/06/a/01.pdf%0A5

Idris, R., Ariffin, S. R., & Ishak, N. M. (2009). Pengaruh Kemahiran Generik dalam Kemahiran Pemikiran Kritikal, Penyelesaian Masalah dan Komunikasi Pelajar Universiti Kebangsaan Malaysia (UKM). *Malaysian Journal of Learning and Instruction (MJLI)*, *6*, 103–140. Retrieved from http://mjli.uum.edu.my/index.php/previous-issues/128-malaysian-journal-of-learning-and-instruction-mjli-vol-6-2009

Ismail, A., & Abiddin, N. Z. (2014). Issues and Challenges of Technical and Vocational Education and Training in Malaysia Towards Human Capital Development. *Middle-East Journal of Scientific Research*, *19*(January 2014), 7–11.

https://doi.org/10.5829/idosi.mejsr.2014.19.icmrp.2

Ismail, S. (2012). *Kesediaan Guru Terhadap Pelaksanaan Mata Pelajaran Reka Bentuk Dan Teknologi (RBT) Sekolah Rendah Di Malaysia*. Tesis Sarjana. UTHM. https://doi.org/10.1017/CBO9781107415324.004

Krejcie, R. V, & Morgan, D. W. (1970). Educational and Psychological Measurement, 607–610.

Labuda, I. (2015). Possibilities of Applying TRIZ Methodology Elements (The 40 Inventive Principles) in The Process of Architectural Design. *Procedia Engineering*, *131*, 476–499. https://doi.org/10.1016/j.proeng.2015.12.443

Nulty, D. D. (2008). The Adequacy of Response Rates to Online and Paper Surveys: What Can Be Done? *Assessment and Evaluation in Higher Education*, *33*(3), 301–314. https://doi.org/10.1080/02602930701293231

Omar, A. (2015). The Effects of Inventive Thinking Programme on Bahasa Melayu Students' Inventive Thinking Ability and Dispositions. *Journal of Management Research*, *7*(December). https://doi.org/10.5296/jmr.v7i2.6923

Osterman, M. D. (2015). *Exploring Relationships Between Thinking Style and Sex, Age, Academic Major, Occupation and Levels of Arts Engagement Among Professionals Working in Museums. FIU Electronic Theses and Dissertations*. FIU Electronic Theses and Dissertations University, Florida International University. Retrieved from http://digitalcommons.fiu.edu/etd/2277

Rasul, M. S., Hilmi, Z., Ashari, M., Azman, N., Amnah, R., & Rauf, A. (2015). Transforming TVET in Malaysia : Harmonizing the Governance Structure in a Multiple Stakeholder Setting. *TVET-Online.Asia*, (4), 1–13.

Roy, J. (2012). *Elementary Teachers ' Perceptions of Their Teaching Practices to Foster Creative Thinking in Their Students*. Curriculum and Instruction Undergraduate Honors Theses. 1. University of Arkansas, Fayetteville. Retrieved from http://scholarworks.uark.edu/cieduht Recommended

Tee, T. K., Saien, S., Yee, M. H., & Mohamad, M. M. (2017). TRIZ : An Alternate Way to Solve Problem for Student. *International Journal of Academic Research in Business and Social Sciences*, *7*(2), 486–492. https://doi.org/10.6007/IJARBSS/v7-i2/2658

Temel, S. (2014). The Effects of Problem-Based Learning on Pre-Service Teachers ' Critical Thinking Dispositions and Perceptions of Problem-Solving Ability. *South African Journal of Education*, *34*(1), 1–20.

Toivonen, T. (2015). Continuous innovation - Combining Toyota Kata and TRIZ for sustained innovation. *Procedia Engineering*, *131*, 963–974. https://doi.org/10.1016/j.proeng.2015.12.408

Wan Mohamed, W. A., & Omar, B. (2010). Through Work-Based Learning Among Community College. *Journal of Technical Education and Training (JTET)*, *2*(1), 1–8.

Wang, R., & Zhang, J. (2017). A Study on the Application of TRIZ in Innovative Design of Electronic Products. *Revista de La Facultad de Ingeniería U.C.V.*, *32*(15), 578–582.